

FEDERAL AVIATION AGENCY
Washington 25, D.C.
TECHNICAL STANDARD ORDER
Regulations of the Administrator
Part 514

Subject: AIRBORNE RADIO MARKER RECEIVING EQUIPMENT
OPERATING ON 75 MC. (FOR AIR CARRIER AIRCRAFT)

TSO-C35c

Technical Standards Orders for Aircraft Materials, Parts and Appliances

Part 514 which contains minimum performance standards and specifications for materials, parts, and appliances used in aircraft consists of two subparts. Subpart A contains the general requirements applicable to all Technical Standard Orders. Subpart B contains the technical standards and specifications to which a particular product must conform.

ANY TECHNICAL STANDARD ORDER MAY BE OBTAINED BY SENDING A REQUEST TO FAA, WASHINGTON 25, D.C.

Subpart A—GENERAL

§ 514.0 Definition of terms.

As used in this part:

(a) "Administrator" means the Administrator of the Federal Aviation Agency or any person to whom he has delegated his authority in the matter concerned.

(b) "FAA" means Federal Aviation Agency.

(c) "Manufacturer" means a person who controls the design and quality of an article produced under the TSO system, including all parts thereof and processes and services related thereto obtained from outside sources.

(d) "Article" means the materials, parts, or appliances for which approval is required under the Civil Air Regulations for use on civil aircraft.

§ 514.1 Basis and purpose.

(a) *Basis.* Section 601 of the Federal Aviation Act of 1958, and §§ 3.18, 4a.31, 4b.18, 5.18, 6.18, 7.18, 10.21, 13.18, and 14.18 of this title (Civil Air Regulations).

(b) *Purpose.* (1) This part prescribes in individual Technical Standard Orders the minimum performance and quality control standards for FAA approval of specified articles used on civil aircraft,¹ and prescribes the methods by which the manufacturer of such articles shall show compliance with such standards in order to obtain authorization for the use of the articles on civil aircraft.

(2) The performance standards set forth in the individual Technical Standard Orders are those standards found necessary by the Administrator to assure that the particular article when used on civil aircraft will operate satisfactorily, or accomplish satisfactorily its in-

tended purpose under specified conditions.

§ 514.2 TSO authorization.

(a) *Privileges.* No person shall identify an article with a TSO marking unless he holds a TSO authorization and the article meets the applicable TSO standards prescribed in this part.

(b) *Letters of acceptance issued prior to July 1, 1962.* An FAA letter of acceptance of a statement of conformance issued for an article prior to July 1, 1962, is an authorization within the meaning of this part and the holder thereof may continue to manufacture such article without obtaining an additional TSO authorization, but shall comply with the requirements of § 514.3 through § 514.10.

(c) *Application.* The manufacturer or his duly authorized representative shall submit an application for a TSO authorization together with the following documents (See Appendix A of this subpart for sample application) to the Chief, Engineering and Manufacturing Branch, Flight Standards Division, in the region in which the manufacturer is located.²

(1) A statement of conformance certifying that the applicant has complied with the provisions of Subpart A and the article meets the applicable performance standards established in Subpart B of this part (See Appendix B of this subpart for sample statement of conformance);

(2) Copies of the technical data required in the performance standards set forth in Subpart B of this part for the particular article;

(3) A description of his quality control system in the detail specified in § 1.36 of this title (Civil Air Regulations). In complying with

this provision the manufacturer may refer to current quality control data filed with the Agency, as a part of a previous application.

NOTE: When a series of minor changes in accordance with § 514.5 is anticipated, the manufacturer may set forth in his application the basic model numbered article with open brackets after it to denote that suffix change letters will be added from time-to-time e.g., Model No. 100 ().

(d) *Issuance.* (1) Upon receipt of the application and adequate supporting documents specified in paragraph (c) of this section to substantiate the manufacturer's statement of conformance with the requirements of this part and his ability to produce duplicate articles in accordance with the provisions of this part, the applicant will be given an authorization to identify his article with the applicable TSO marking.

(2) If the application is deficient in respect to any requirements, the applicant shall, upon request by the Chief, Engineering and Manufacturing Branch, submit such additional information as may be necessary to show compliance with such requirements. Upon the failure of the applicant to submit such additional information within 30 days after the date of the request therefor, his application will be denied and he will be so notified by the Chief, Engineering and Manufacturing Branch.

NOTE: The applicant will be issued an authorization or notified of the denial of his application within 30 days after the date of receipt of such application or, in the event that additional information has been requested, within 30 days after the date of receipt of such additional information.

¹ Articles may also be approved and manufactured for use on civil aircraft as a part of the type design of a type certificate for an aircraft engine or propeller.

² Regional Offices are located at New York, Atlanta, Kansas City, Fort Worth, Los Angeles, Anchorage.

§514.3 Conditions on authorizations.

The manufacturer of an article under an authorization issued under the provisions of this part shall—

(a) Manufacture such article in accordance with the requirements of Subpart A and the performance standards contained in the applicable TSO of Subpart B of this part;

(b) Conduct the required tests and inspections, and establish and maintain a quality control system adequate to assure that such article, as manufactured, meets the requirements of paragraph (a) of this section and is in a condition for safe operation;

(c) Prepare and maintain for each type or model of such article a current file of complete technical data and records in accordance with § 514.6; and

(d) Permanently and legibly mark each such article with the following information:

(1) Name and address of the manufacturer,

(2) Equipment name, or type or model designation,

(3) Weight to the nearest tenth of a pound,

(4) Serial number and/or date of manufacturer, and

(5) Applicable Technical Standard Order (TSO) number.

§514.4 Deviations.

Approval for a deviation from the performance standards established in Subpart B may be obtained only if the standard or standards for which deviation is requested are compensated for by factors or design features which provide an equivalent level of safety. A request for such approval together with the pertinent data shall be submitted by the manufacturer to the Chief, Engineering and Manufacturing Branch of the Region in which the applicant is located.

§514.5 Design changes.

(a) *By Manufacturer*—(1) *Minor changes.* The manufacturer of an article under an authorization issued pursuant to the provisions of this part may make minor design changes to the article without further approval by the FAA. In such case the changed article shall retain the original model number and the manufacturer shall forward to the Chief, Engineering and Manufacturing Branch such revised data as may be necessary for compliance with § 514.2(c).

(2) *Major changes.* If the changes to the article are so extensive as to require a substantially complete investigation to determine compliance with the performance standards established in Subpart B, the manufacturer shall assign a new type or model designation to the

article and submit a new application in accordance with the provisions of § 514.2(c).

(b) *By persons other than the manufacturer.* Design changes to an article by a person other than the manufacturer who submitted the statement of conformance for such article are not eligible for approval under this part, unless such person is a manufacturer as defined in § 514.0 and applies for authorization under § 514.2(c).

NOTE: Persons other than a manufacturer may obtain approval for design changes to a product manufactured under a TSO pursuant to the provisions of Part 18 or the applicable airworthiness regulations.

§514.6 Retention of data and records.

(a) A manufacturer holding an authorization issued pursuant to the provisions of this part shall, for all articles manufactured under such authorization on and after July 1, 1962, maintain and keep at his factory:

(1) A complete and current technical data file for each type or model of article which shall include the design drawings and specifications. This technical data shall be retained for the duration of his operation under the provisions of this part.

(2) Complete and current inspection records to show that all inspections and tests required to ensure compliance with this part have been properly accomplished and documented. These records shall be retained for at least two years.

(b) The data specified in paragraph (a)(1) of this section shall be identified and copies transferred to the FAA for record purposes in the event the manufacturer terminates his business or no longer operates under the provisions of this part.

§514.7 Inspection and examination of data, articles or manufacturing facilities.

The manufacturer shall, upon request, permit an authorized representative of the FAA to inspect any article manufactured pursuant to this part, and to observe the quality control inspections and tests and examine the manufacturing facilities and technical data files for such article.

§514.8 Service difficulties.

Whenever the investigation of an accident or a service difficulty report shows an unsafe feature or characteristic caused by a defect in design or manufacture of an article, the manufacturer shall upon the request of the Chief, Engineering and Manufacturing Branch, report the results of his investigation and the action, if any, taken or proposed by him to correct the defect in design

or manufacture (e.g., service bulletin, design changes, etc.). If the defect requires a design change or other action to correct the unsafe feature or characteristic, the manufacturer shall submit to the Chief, Engineering and Manufacturing Branch, the data necessary for the issuance of an airworthiness directive containing the appropriate corrective action.

§514.9 Noncompliance.

Whenever the Administrator finds that a manufacturer holding an authorization issued pursuant to the provisions of this part has identified an article by a TSO marking and that such article does not meet the applicable performance standards of this part, the Administrator may, upon notice thereof to the manufacturer, withdraw the manufacturer's authorization and, where necessary, prohibit any further certification or operation of a civil aircraft upon which such article is installed until appropriate corrective action is taken.

§514.10 Transferability and duration.

An authorization issued pursuant to the provisions of this part shall not be transferred and is effective until surrendered, or withdrawn, or otherwise terminated by the Administrator.

APPENDIX A SAMPLE APPLICATION FOR TSO AUTHORIZATION

(Date) _____

(Addressed to: Chief, Engineering and Manufacturing Branch, Federal Aviation Agency, Region.)

Application is hereby made for authorization to use the Technical Standard Order procedures.

Enclosed is a statement of conformance for the article to be produced under TSO-C-_____.

The required quality control data¹ are transmitted: (herewith) (under separate cover). Signed _____

APPENDIX B SAMPLE STATEMENT OF CONFORMANCE

(Date) _____

(Addressed to: Chief, Engineering and Manufacturing Branch, Flight Standards Division, Federal Aviation Agency.)

The undersigned hereby certifies that the article listed below by model, type or part number has been tested and meets the performance standards of Technical Standard Order C-_____. In addition, all other applicable provisions of Part 514 of the Regulations of the Administrator have been met.

The technical data required by the TSO in the quantity specified are transmitted: (herewith) (under separate cover).

Authorization to use TSO identification on this article is requested.

Signed _____

¹ Reference may be made to data already on file with the FAA.

§ 514.37 Airborne radio marker receiving equipment operating on 75 mc. (for air carrier aircraft)—TSO-C35c.

(a) *Applicability.* (1) Minimum performance standards are hereby established for airborne radio marker receiving equipment operating on 75 mc. which is to be used on civil aircraft of the United States engaged in air carrier operations. New models of airborne radio marker receiving equipment operating on 75 mc. manufactured for use on civil air carrier aircraft on or after the effective date of this section shall meet the minimum performance standards contained in Federal Aviation Agency Standard entitled "Minimum Performance Standards for Airborne Radio Marker Receiving Equipment Operating on 75 mc.", dated April 6, 1962, and Radio Technical Commission for Aeronautics Paper 120-61/DO-108¹ entitled, "Environmental Test Procedures Airborne Electronic Equipment", dated July 13, 1961, with the exceptions to these standards listed in subparagraph (2) of this paragraph.

(2) Radio Technical Commission for Aeronautics Paper 120-61/DO-108 outlines various test procedures which define the environmental extremes over which the equipment shall be designed to operate. Some test procedures have categories established and some do not. Where categories are established, only equipment which qualifies under the following categories, as specified in RTCA Paper 120-61/DO-108, is eligible under this order:

(i) Temperature - Altitude Test—Categories A, B, C, or D;

(ii) Humidity Test—Categories A or B;

(iii) Vibration Test—Categories A, B, C, D, E, or F;

(iv) Audio - Frequency Magnetic Field Susceptibility Test—Categories A or B;

(v) Radio-Frequency Susceptibility Test—Category A; and

(vi) Emission of Spurious Radio-Frequency Energy Test—Category A.

(b) *Marking.* (1) In addition to the marking requirements of § 514.3 (d), the equipment shall be marked to indicate the environmental extremes over which it has been designed to operate. There are seven environmental test procedures outlined in RTCA Paper 120-61/DO-108 which have categories established. These should be identified on the nameplate by the words "environmental categories" or, as abbreviated, "Env. Cat." followed by seven letters which identify the categories designated in RTCA Paper 120-61/DO-108. Reading from left to right, the category designations shall appear on the nameplate in the following order so that they may be readily identified:

(i) Temperature - Altitude Test Category;

(ii) Humidity Test Category;

(iii) Vibration Test Category;

(iv) Audio - Frequency Magnetic Field Susceptibility Test Category;

(v) Radio-Frequency Susceptibility Test Category;

(vi) Emission of Spurious Radio-Frequency Energy Test Category; and

(vii) Explosion Test.

(2) Equipment which meets the explosion test requirement shall be identified by the letter "E". Equipment which does not meet the explosion test requirement shall be identified by the letter "X". A typical

nameplate identification would be as follows: Env Cat. DABAAAX.

(3) In some cases such as under the Temperature-Altitude Test Category, a manufacturer may wish to substantiate his equipment under two categories. In this case, the nameplate shall be marked with both categories in the space designated for that category by placing one letter above the other in the following manner: Env. Cat. $\frac{A}{D}$ ABAAAX.

(4) Each major component of equipment (antenna, power supply, etc.) shall be identified with at least the manufacturer's name, TSO number, and the environmental categories over which the equipment component is designed to operate.

(c) *Data requirements.* Six copies each of the following, except where noted, together with the statement of conformance, shall be furnished to the Chief, Engineering and Manufacturing Branch, Flight Standards Division, Federal Aviation Agency, in the region in which the manufacturer is located:

(1) Manufacturer's operating instructions and equipment limitations.

(2) Installation procedures with applicable schematic drawings, wiring diagrams, and specifications. Indicate any limitations, restrictions, or other conditions pertinent to installation.

(3) One copy of the manufacturer's test report.

(d) *Effective date.* July 15, 1963.

¹ Copies of this paper may be obtained from the RTCA Secretariat, Room 1072, T-5 Building, 16th and Constitution Avenue, N.W., Washington 25, D.C. at a cost of 75 cents per copy.

**FEDERAL AVIATION AGENCY
WASHINGTON, D.C.**

**MINIMUM PERFORMANCE STANDARDS FOR
AIRBORNE RADIO MARKER RECEIVING EQUIPMENT
OPERATING ON 75 MC.**

APRIL 6, 1962

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INTRODUCTION

This document sets forth minimum performance standards for airborne radio marker receiving equipment operating on 75 mc.

Compliance with these standards by manufacturers and users is required as a means of assuring that the equipment will satisfactorily perform its intended function.

Inasmuch as the measured values of radio equipment performance characteristics may be a function of the method of measurement, standard test conditions and methods of test are also included in this document.

The word "equipment" as used herein includes all of the components or units necessary (as determined by the equipment manufacturer) for the equipment to perform properly its intended function. For example, an airborne radio marker receiving "equipment" may include an antenna, a receiver unit, a control box, a power supply, a shock mount, etc. In the case of this example, all of the foregoing components or units comprise the "equipment". It should not be inferred from this example, however, that every airborne radio marker receiving equipment will necessarily include all of the foregoing components. This will depend on the design used by the equipment manufacturer.

MINIMUM PERFORMANCE STANDARDS FOR AIRBORNE RADIO MARKER RECEIVING EQUIPMENT OPERATING ON 75 MC.

1.0 GENERAL STANDARDS

1.1 Rating of Components: The equipment shall not incorporate in its design any components of such rating that, when the equipment is operated throughout the range of the specified environmental tests, the rating established by the manufacturer of the component is exceeded. For electron tubes, the continuous commercial service rating of the tube manufacturer is applicable except for the heaters and filaments. The voltage applied to the heaters and filaments of electron tubes shall be within 5% of the manufacturer's rating when the equipment is operated under standard operating conditions. When the heaters and filaments are connected in series, the 5% tolerance shall apply to the sum of their voltage ratings.

1.2 Operation of Controls: The design of the equipment shall be such that the controls intended for use during flight cannot be operated in any possible position combination or sequence which would result in a condition whose presence or continuation would be detrimental to the reliability of the equipment.

1.3 Effects of Test: Unless otherwise provided, the design of the equipment shall be such that, subsequent to the application of the specified tests, no discernible condition exists which would be detrimental to the continued performance of the equipment.

1.4 RF Gain Control: Means shall be provided for so fixing the adjustment of receiver sensitivity, that when flying over a representative number of Z-markers and/or ILS outer markers at 1,000 feet above the ground at 120 m.p.h. ground speed an average light "on" time between 12 and 15 seconds is obtained. The fixed sensitivity adjustment control shall not be readily variable by flight personnel. When the equipment is designed for inflight control of receiver sensitivity, the inflight controls shall not be capable of adjusting the receiver sensitivity below the fixed setting level.

1.5 Lamp Actuation (Single Lamp): In the case of equipment designed to operate a single lamp, the lamp shall be actuated by each of the three modulation frequencies.

1.6 Lamp Actuation (Three Lamps): In the case of equipment designed to operate a separate lamp for each of the three modulation frequencies, the 400 c.p.s. tone shall actuate the blue light, the 1,300 c.p.s. tone the amber light, and the 3,000 c.p.s. tone the white light.

2.0 MINIMUM PERFORMANCE STANDARDS UNDER STANDARD TEST CONDITIONS.

The test procedures, applicable to a determination of the performance of airborne 75 mc. radio marker receiving equipment under standard test conditions, are set forth in Appendix A of this report.

2.1 Audio Frequency Response: The total spread in audio output of the receiver shall not exceed 9 db when the frequency of the modulation on the input signal is varied over the combined ranges of 380 to 420 c.p.s., 1,235 to 1,365 c.p.s., and 2,850 to 3,150 c.p.s. The RF level of the input signal shall be ten times that producing lamp operate threshold at 1,300 c.p.s.

2.2 Lamp Frequency Response: The variation RF input level required to produce lamp operate threshold shall not exceed 9 db when the frequency of the modulation on the input signal is varied over the combined ranges of 380 to 420 c.p.s., 1,235 to 1,365 c.p.s., and 2,850 to 3,150 c.p.s.

2.3 Audio Level Characteristic: The receiver audio output at each of the modulation frequencies of 400, 1,300 and 3,000 c.p.s. shall not vary more than 10 db when the level of the RF input signal is varied over the range from that producing lamp operate threshold to 200,000 μ v.

2.4 Rated Audio Power Output: The audio output power of the receiver shall be not less than the rated output when an RF signal having a level ten times that producing lamp operate threshold at 1,300 c.p.s. is applied to the receiver input.

2.5 Audio Noise Level—Without Signal:

- (a) The level of the noise output of the receiver, in the absence of an RF input signal, shall be at least 35 db below the output obtained with an RF input signal having a level ten times that producing lamp operate threshold.
- (b) The level of the output at discrete audio frequencies, in the absence of an RF input signal, shall be at least 40 db below the output obtained with an RF input signal having a level ten times that producing lamp operate threshold. Equipment designed for an AC power source shall meet this requirement at all power frequencies within the range for which the equipment is designed.

2.6 Audio Noise Level—With Signal:

- (a) The receiver output signal plus noise-to-noise ratio shall be at least 20 db over the range of RF input signal level from that producing lamp operate threshold to 200,000 μ v.
- (b) The level of the receiver output at discrete audio frequencies shall be at least 30 db below the signal plus noise output over the range of RF input signal level from that producing lamp operate threshold to 200,000 μ v. Equipment designed for an AC power source shall meet this requirement at all power frequencies within the range for which the equipment is designed.

2.7 Distortion: Over the range of RF signal input level from that producing lamp operate threshold to 200,000 μ v, the combined noise and distortion in the equipment output shall not exceed 30% of the total output.

2.8 Output Regulation: With an output load of 200% of design impedance and with an output load of 50% of design impedance, the distortion in the output shall not exceed 30%, and the output voltage level shall be within 2:1 of the level when the load is that for which the receiver is designed.

2.9 Emission of Spurious Radio-Frequency Energy: The levels of conducted and radiated spurious radio-frequency energy emitted by the equipment shall not exceed those levels specified in Appendix A of RTCA Paper 120-61/DO-108—"Environmental Test Procedures—Airborne Electronic Equipment", dated July 13, 1961, for the aircraft category for which the equipment is designed.

2.10 Sensitivity Depression

- (a) The level of the RF input signal at 75 mc. required to produce lamp operate threshold, shall not increase more than 4 db when there is added to the receiver input channels 4 and 5 television signals having a level of 3.5 v.
- (b) The level of the RF input signal at 75 mc., required to produce lamp operate threshold, shall not increase more than 4 db when there is added to the receiver input a 0.5 v. RF signal frequency modulated 1,300 c.p.s. at a deviation of ± 15 kc. This standard shall be met over the FM signal frequency ranges of 72.02—74.58 mc. and 75.42—75.98 mc.

2.11 Input Operating Differential: The ratio of the RF input signal level required to produce lamp operate threshold when the RF input signal is increasing to the RF input signal level required to produce lamp operate threshold when the RF input signal level is decreasing shall not exceed 2:1.

2.12 Voltage Standing Wave Ratio: When the receiver is designed for use with an antenna transmission line, the voltage standing wave ratio produced on the

transmission line having a characteristic impedance for which the receiver input circuit is designed shall not exceed a value of 2 to 1 when the transmission line is connected to the receiver input and a 75 mc. signal is fed to the receiver through the transmission line.

2.13 Cross Modulation:

- (a) The voltage across the indicator lamp(s) due to cross modulation shall not exceed the voltage at lamp operate threshold nor shall the audio output exceed one-half the manufacturer's rated output when there are applied simultaneously to the receiver input an unmodulated carrier at center response frequency having a level equal to that of a signal producing lamp operate threshold and a television signal having a level of 3.5 v. This standard shall be met at the television signal frequencies of channels 2 through 6.
- (b) The voltage across the indicator lamp(s) due to cross modulation shall not exceed the voltage at lamp operate threshold nor shall the audio output exceed one-half the manufacturer's rated output when there are applied simultaneously to the receiver input an unmodulated carrier at center response frequency having a level equal to that of a signal producing lamp operate threshold and a 0.5 v. RF signal frequency modulated 1,300 c.p.s. at a deviation of ± 15 kc. This standard shall be met over the FM signal frequency ranges of 72.02—74.58 mc. and 75.42—75.98 mc.

2.14 Spurious Response:

- (a) The voltage across the indicator lamp(s) shall not exceed the lamp operate threshold voltage nor shall the audio output exceed one-half the manufacturer's rated output when an RF input signal of 0.5 v. amplitude modulated 30% in turn of 400, 1,300, and 3,000 c.p.s., is varied over the frequency range of 0.190 mc. to 1,500 mc., excluding the band from 65 to 85 mc.
- (b) The voltage across the indicator lamp(s) shall not exceed the lamp operate threshold voltage nor shall the audio output exceed one-half the manufacturer's rated output when an RF input signal of 0.5 v., frequency modulated in turn at 400, 1,300 and 3,000 c.p.s. at a deviation of ± 15 kc, is varied over the frequency ranges of 72.02—74.58 mc. and 75.42—75.98 mc.
- (c) The voltage across the indicator lamp(s) shall not exceed the lamp operate threshold voltage nor shall the audio output exceed one-half the manufacturer's rated output when an RF input signal of 3.5 v. with television signal modulation is applied at television signal frequencies of channels 2 through 6.

2.15 Nose Bandwidth: The level of the input signal required to produce lamp operate threshold over the input signal frequency range of 75 mc. minus 10 kc. to 75 mc. +10 kc. shall not be more than 6 db above the input required to produce lamp operate threshold at the frequency of maximum response.

2.16 Lamp Operate Selectivity: In the case of equipment designed to operate a separate lamp for each of the three modulation frequencies of 400, 1,300 and 3,000 c.p.s., the voltage across the two lamps not intended to be operated shall be less than 30% of rated, lamp voltage over the input signal range from that producing lamp operate threshold to 200,000 μ v.

2.17 Antenna Polarization: The antenna to be used on the aircraft shall be assigned so as to produce, when installed according to the manufacturer's instructions, a maximum response from 75 mc. signals radiated from below the aircraft with the received electric field component parallel to the line of flight.

2.18 Lamp Actuation—Keying: The variation in intensity of the light from the lamps shall indicate the keying of the modulation of the input signal. The modulation of the input signal shall be keyed at the rate of six dots per second, and the modulation ON time to modulation OFF time ratio shall be 1:1.

3.0 MINIMUM PERFORMANCE STANDARDS UNDER ENVIRONMENTAL TEST CONDITIONS

Unless otherwise specified, the test procedures applicable to a determination of the performance of this equipment under environmental test conditions are set forth in RTCA Paper 120-61/DO-108 "Environmental Test Procedures—Airborne Electronic Equipment" dated July 13, 1961.

3.1 Temperature—Altitude Test:

3.1.1 Low Temperature Test: When the equipment is subjected to this test:

- (a) The RF input required to produce lamp operate threshold shall be within 6 db of that required under standard operating conditions.
- (b) The audio output with an input signal having a level of ten times that producing lamp operate threshold shall be within 6 db of the output obtained under standard operating conditions.

3.1.2 High Temperature Test:

- (a) When the equipment is operated at the High Short-Time Operating Temperature:
 - (1) All mechanical devices shall operate satisfactorily.
 - (2) There shall be no evidence of materials, such as grease or potting and sealing compounds, exuding or dripping from the equipment.
- (b) When the equipment is operated at the High Operating Temperature the audio output with an input signal having a level of ten times that producing lamp operate threshold

shall be within 6 db of the output obtained under standard operating conditions.

3.1.3 Decompression Test (When Required): When the equipment is subjected to this test the performance requirements of paragraphs 2.3 and 2.4 shall be met.

3.1.4 Altitude Test: When the equipment is subjected to the altitude test, the performance requirements of paragraphs 2.3 and 2.4 shall be met.

3.2 Humidity Test:

- (a) After being subjected to humidity and within 15 minutes after primary power is applied, the lamp operate sensitivity shall be within 4:1 of that obtained under standard operating conditions. The audio output shall be within 6 db of that obtained under standard operating conditions when the RF signal input level in each case is ten times that producing lamp operate threshold under standard operating conditions.
- (b) Within four hours from the time primary power is applied, the lamp operate sensitivity shall be within 2 db of that obtained under standard operating conditions. The audio output shall be within 2 db of that obtained under standard operating conditions when the RF signal level in each case is ten times that producing lamp operate threshold under standard operating conditions.

3.3 Shock Test:

- (a) Following the application of the Operational Shocks, the lamp operate sensitivity shall be within 2 db of that obtained under standard operating conditions. The audio output shall be within 2 db of that obtained under standard operating conditions when the RF signal level in each case is ten times that producing lamp operate threshold under standard operating conditions.
- (b) Following the application of the Crash Safety Shocks, the equipment under test shall have remained in its mounting, and no parts of the equipment or its mounting shall have become detached and free of the equipment. Paragraph 1.3 does not apply.¹

3.4 Vibration Test: When subjected to this test, the standards of paragraphs 2.5(a) and 2.6(a) shall be met. The level of the input signal required to produce lamp operate threshold shall be within 2 db of that required under standard operating conditions.

3.5 Temperature Variation Test: When the equipment is subjected to this test, the standards of paragraph 2.15 shall be met.

¹ The application of this test and that required by paragraph 3.6(c) may result in damage to the equipment under test. Therefore, they may be conducted after the other tests are completed. Paragraph 1.3 does not apply.

3.6 Low Voltage Test :

- (a) When the primary power voltage(s) of DC operated equipment is 80% and when that of AC operated equipment is 87½% of standard test voltage(s), the equipment shall start and continue to operate electrically and mechanically. Degradation of performance is tolerable.
- (b) DC operated equipment shall operate satisfactorily within two (2) minutes upon returning the primary power voltage(s) to normal after the gradual reduction of the primary power voltage(s) from 80% to 50% of standard test voltage(s).
- (c) The gradual reduction of the primary power voltage(s) of DC operated equipment from 50% to 0% of standard test voltage(s) shall produce no evidence of the presence of fire or smoke.²

² The application of this test and that required by paragraph 3.3(b) may result in damage to the equipment under test. Therefore, they may be conducted after the other tests are completed. Paragraph 1.3 does not apply.

3.7 Conducted Voltage Transient Test :

- (a) Following the Intermittent Transient Test, the performance requirements of paragraph 2.4 shall be met.
- (b) During the Repetitive Transients Tests, the performance requirements of paragraphs 2.5(a) and 2.6(a) shall be met.

3.8 Conducted Audio-Frequency Susceptibility Test : when the equipment is subjected to this test, the performance requirements of paragraphs 2.5(a) and 2.6(a) shall be met.

3.9 Audio-Frequency Magnetic Field Susceptibility Test : When the equipment is subjected to this test, the performance requirements of paragraphs 2.5 (a) and 2.6(a) shall be met.

3.10 Radio-Frequency Susceptibility Test (Radiated and Conducted) : When the equipment is subjected to this test, the receiver output shall be at least 40 db below the rated power output. The test signal shall be modulated 30% at 1,300 c.p.s.

3.11 Explosion Test (When Required) : During the application of this test, the equipment shall not cause detonation of the explosive mixture within the test chamber.

APPENDIX A

TEST PROCEDURES

AIRBORNE RADIO MARKER RECEIVING EQUIPMENT

OPERATING ON 75 MC.

NOTE:

THE TEST PROCEDURES SET FORTH IN PART II OF THIS APPENDIX ARE SATISFACTORY FOR USE IN DETERMINING THE PERFORMANCE OF AIRBORNE RADIO MARKER RECEIVING EQUIPMENT OPERATING ON 75 MC. *TEST PROCEDURES WHICH PROVIDE EQUIVALENT INFORMATION MAY BE USED.*

PART I

DEFINITIONS OF TERMS AND CONDITIONS OF TEST

The following definitions of terms and conditions of test are applicable to the equipment tests specified herein:

- (a) *Power Input Voltage—Direct Current*: Unless otherwise specified, when the receiver is designed for operation from a direct current power source, all measurements shall be conducted with the power input voltage adjusted to 13.75 v., $\pm 2\%$ for 12-14 v. equipment, or to 27.5 v. $\pm 2\%$ for 24-28 v. equipment. The input voltage shall be measured at the receiver power input terminals.
- (b) *Power Input Voltage—Alternating Current*: Unless otherwise specified, when the receiver is designed for operation from an alternating current power source, all tests shall be conducted with the power input voltage adjusted to design voltage $\pm 2\%$. In the case of receivers designed for operation from a power source of essentially constant frequency (e.g., 400 c.p.s.), the input frequency shall be adjusted to design frequency $\pm 2\%$. In the case of receivers designed for operation from a power source of variable frequency (e.g., 350 to 1,000 c.p.s.), tests shall be conducted with the input frequency adjusted to within 5% of a selected frequency within the range for which the equipment is designed.
- (c) *Adjustment of Equipment*: The circuits of the receiver shall be properly aligned and otherwise adjusted in accordance with the manufacturer's recommended practices prior to the application of the specified tests.
- (d) *Test Instrument Precautions*: Due precautions shall be taken to prevent the introduction of errors resulting from the connection of headphones, voltmeters, oscilloscopes, and other test instruments across the input and output impedances of the receiver during the conduct of the tests.
- (e) *Ambient Conditions*: Unless otherwise specified, all tests shall be conducted under conditions of ambient room temperature, pressure, and humidity. However, the room temperature shall not be lower than 10° C.
- (f) *Warmup Period*: Unless otherwise specified, all test shall be conducted after a warmup period of not less than fifteen (15) minutes.
- (g) *Connected Loads*: Unless otherwise specified, all tests shall be performed with the receiver out-

puts connected to loads having the impedance value for which the receiver is designed.

- (h) *RF Input Voltage*: The "RF input voltage" is defined as the "open circuit" voltage of the circuit connected to the receiver input. The circuit connected to the receiver input shall be the equivalent of the RF input voltage in series with an impedance having a resistance within 10% and a reactance of not more than 10% of the characteristic impedance of the transmission line for which the receiver is designed.

NOTE: The RF input voltages specified herein are for the case of a receiver designed for a transmission line having a nominal characteristic impedance of 52 ohms. In the case of a receiver designed for a transmission line having a nominal characteristic impedance of other than 52 ohms, the RF input voltage values shall be computed according to the following equation:

$$E_2 = \sqrt{E_1^2 \frac{R_2}{52}}$$

Where E_2 is the RF input voltage to be used in the case of a receiver designed for a transmission line having a nominal characteristic impedance other than 52 ohms.

E_1 is the RF input voltage specified herein.

R_2 is the nominal characteristic impedance of the transmission line for which the receiver is designed.

- (i) *Test Signal Modulation*: Unless otherwise specified, the RF input signal shall be a 75 mc. $\pm 0.005\%$ signal amplitude modulated 95% successively at $400 \pm 1\%$ c.p.s., $1,300 \pm 1\%$ c.p.s., and $3,000 \pm 1\%$ c.p.s.
- (j) *Lamp Operate Threshold*: The term "lamp operate threshold," is defined as that condition wherein an increase of 5% or less in RF input signal voltage results in lighting of the indicator lamp. In the case of receivers in which the voltage across the indicator lamp(s) varies with the signal input, the lamp(s) is considered lit when the voltage appearing across the lamp terminals is one-half or more of its average rated voltage.
- (k) *Receiver Sensitivity Setting*: Unless otherwise specified, the receiver gain shall be adjusted to produce lamp operate threshold with an RF input signal level of 2,000 μ v.

PART II

DETAILED TEST PROCEDURES

T-1 AUDIO FREQUENCY RESPONSE

Equipment Required:

- RF Signal Generator (Hewlett Packard Model 608B or equivalent).
- AF Signal Generator (Hewlett Packard Model 200B or equivalent).
- Audio Output Meter (General Radio Model 583A or equivalent).
- Voltmeter of suitable impedance and range (if required) for determining lamp operate threshold.

Measurement Procedure:

Apply to the receiver input an RF signal having a level ten times that producing lamp operate threshold at 1,300 c.p.s. and measure the audio output over the input signal modulation frequency ranges of 380-420 c.p.s., 1,235-1,365 c.p.s., and 2,850-3,150 c.p.s.

T-2 LAMP FREQUENCY RESPONSE

Equipment Required:

- RF Signal Generator (Hewlett Packard Model 608B or equivalent).
- AF Signal Generator (Hewlett Packard Model 200B or equivalent).
- Voltmeter, if required, of suitable impedance and range for determining lamp operate threshold.

Measurement Procedure:

Apply to the receiver input an RF signal amplitude modulated 95% at each of the following frequencies: 380, 400, 420, 1,235, 1,300, 1,365, 2,850, 3,000, and 3,150 c.p.s. For each modulation frequency, determine the level of the input signal required to produce lamp operate threshold. Compute the difference in db between the maximum and minimum input signal levels.

T-3 AUDIO LEVEL CHARACTERISTIC

Equipment Required:

- RF Signal Generator (Hewlett Packard Model 608B or equivalent).
- AF Signal Generator (Hewlett Packard Model 200B or equivalent).
- Audio Output Meter (General Radio Model 583A or equivalent).
- Voltmeter of suitable impedance and range (if required) for determining lamp operate threshold.

Measurement Procedure:

Apply an RF signal to the receiver input and measure the audio output at each of the modulation frequencies of 400, 1,300, and 3,000 c.p.s. over the RF signal input level range from that producing lamp operate threshold to 200,000 μ v. Determine the difference in db between the maximum and minimum output levels.

T-4 RATED AUDIO POWER OUTPUT

Equipment Required:

- RF Signal Generator (Hewlett Packard Model 608B or equivalent).
- AF Signal Generator (Hewlett Packard Model 200B or equivalent).

Audio Output Meter (General Radio Model 583A or equivalent).

Voltmeter of suitable impedance and range, if required, for determining lamp operate threshold.

Measurement Procedure:

Apply to the receiver input an RF signal having a level ten times that producing lamp operate threshold at 1,300 c.p.s. Determine the audio power output at the modulation frequencies of 400, 1,300, and 3,000 c.p.s.

T-5 AUDIO NOISE LEVEL—WITHOUT SIGNAL

Equipment Required:

- Resistance having a value equal to the impedance for which the receiver output is designed.
- Vacuum Tube Voltmeter (Ballantine Model 300 or equivalent).
- Wave Analyzer (General Radio Model 736A or equivalent).

Measurement Procedure:

Connect to the receiver input an impedance equal to that for which the receiver is designed. Measure: (a) the wide band audio noise output and (b) the output at discrete frequencies over the range of 50 to 10,000 c.p.s.

In the case of receivers designed for an AC power source, determine the maximum audio output over the range of input power frequency for which the equipment is designed.

T-6 AUDIO NOISE LEVEL—WITH SIGNALS

Equipment Required:

- RF Signal Generator (Hewlett Packard Model 608B or equivalent).
- Audio Output Meter (General Radio Model 583A or equivalent).
- Wave Analyzer (General Radio Model 736A or equivalent).

Measurement Procedure:

Apply to the receiver input an RF signal.

- (a) Determine the minimum signal plus noise-to-noise ratio over the range of input signal level from that producing lamp operate threshold to 200,000 μ v.
- (b) Remove the modulation from the input signal and determine the maximum output at discrete frequencies over the range of 50 to 10,000 c.p.s. when the input signal level is varied over the range from that producing lamp operate threshold to 200,000 μ v.

In the case of receivers designed for an AC power source, make the above determinations over the combined ranges of signal input level from that producing lamp operate threshold to 200,000 μ v and input power frequency for which the receiver is designed.

T-7 DISTORTION

Equipment Required:

- RF Signal Generator (Hewlett Packard Model 608B or equivalent).

Distortion and Noise Meter (RCA Model 69B or equivalent).

Measurement Procedure:

Apply to the receiver input an RF signal. Determine the maximum percentage of distortion plus noise at 400, 1,300, and 3,000 c.p.s. at an input signal level producing lamp operate threshold at 1,300 c.p.s. and at an input signal level ten times that producing lamp operate threshold at 1,300 c.p.s.

T-8 OUTPUT REGULATION

Equipment Required:

RF Signal Generator (Hewlett Packard Model 608B or equivalent).

Distortion and Noise Meter (RCA Model 69B or equivalent).

Output load resistors having values equal to 50%, 100%, and 200% of the output load impedance for which the receiver is designed.

Measurement Procedure:

Apply to the receiver input an RF signal having a level ten times that producing lamp operate threshold at 1,300 c.p.s. Determine, at the modulation frequencies of 400, 1,300, and 3,000 c.p.s. the percentage of distortion plus noise in the audio output and the audio output voltage level with output loads equal to 50%, 100%, and 200% of that for which the receiver is designed.

T-9 EMISSION OF SPURIOUS RADIO-FREQUENCY ENERGY

Equipment Required:

See Paragraphs 1 and 2, Page 3 of Appendix A of Paper 120-61/DO-108.

Measurement Procedure:

See Paragraph 3, Page 5, of Appendix A of Paper 120-61/DO-108.

T-10 SENSITIVITY DEPRESSION

Equipment Required:

A Combining Unit as shown in Figure 1.

RF Signal Generator (Hewlett Packard Model 608B or equivalent).

Frequency modulated signal generator.

Television signal amplifier capable of boosting the level of a TV signal to at least 3.5 v. peak. The frequency response characteristic of the amplifier shall be within 3 db over the frequency range from -0.5 mc. to +4 mc. of the video carrier frequency. For the purpose of this test, a signal simulating that of a TV signal may be used. Such simulated TV signal shall be a 3.5 v. peak RF signal pulse modulated at a rate of 60 p.p.s. The pulse duration shall be 800 to 1,000 μ s, and the rise and decay time shall not exceed 0.08 μ s.

Measurement Procedure:

Connect the two signal generators (or the amplitude modulated signal generator and the television signal amplifier) as shown in Figure 1.

Apply a 75 mc. desired signal modulated 1,300 c.p.s. Adjust the signal input level to produce lamp operate threshold.

Apply, successively, a television signal having a level of 3.5 v. and an FM signal modulated 1,300 c.p.s. at a deviation of ± 15 kc. and having a level of 0.5 v. and determine the db increase in level of the desired signal required to produce lamp operate threshold. Conduct this test at television channel frequencies 4 and 5 in the case of the television signal and at 74.6 mc. and 75.4 mc. in the case of the FM modulated signal.

T-11 INPUT OPERATING DIFFERENTIAL

Equipment Required:

RF Signal Generator (Hewlett Packard Model 608B or equivalent).

Measurement Procedure:

Apply to the receiver input an RF signal. Determine the ratio in db of the RF input signal level required to produce lamp operate threshold when the input signal level is slowly increasing to the RF input signal level required to produce lamp operate threshold when the input signal level is slowly decreasing.

T-12 VOLTAGE STANDING WAVE RATIO

Equipment Required:

RF Signal Generator (Hewlett Packard Model 608B or equivalent).

Slotted line or impedance bridge.

Measurement Procedure:

(a) When the slotted line is used:

Connect the slotted line between the receiver input and the signal generator. Turn the receiver on and operate it normally. Set the level of the input signal below the level which overloads the receiver input circuit. Measure the maximum and minimum voltages along the slotted line and calculate the VSWR using the following equation:

$$\text{VSWR} = \frac{\text{Max. voltage along the slotted line}}{\text{Min. voltage along the slotted line}}$$

(b) When the impedance bridge is used, measure the impedance of the input circuit and compute the VSWR.

T-13 CROSS MODULATION

Equipment Required:

AM Signal Generator (Hewlett Packard Model 608B or equivalent).

FM signal generator.

Television signal amplifier capable of boosting the level of a TV signal to at least 3.5 v. peak. The frequency response characteristic of the amplifier shall be within 3 db over the range from -0.5 mc. to +4 mc. of the video carrier frequency. For the purpose of this test, a simulated TV signal may be used. Such simulated TV signal shall be an RF signal pulse

modulated at a rate of 60 p.p.s. The pulse duration shall be 800 to 1,000 μ s, and the rise and decay time shall not exceed 0.08 μ s.

A Combining Unit as shown in Figure 1.

Audio Output Meter (General Radio Model 583A or equivalent).

Measurement Procedure:

Connect the two signal generators together by means of the "Combining Unit" as shown in Figure 1.

Apply to the receiver input a 75 mc. desired signal modulated 1,300 c.p.s. Adjust the signal input level to produce lamp operate threshold. Remove the modulation from the desired carrier.

Apply, successively, a television signal having a level of 3.5 v. and an FM signal modulated 1,300 c.p.s. at a deviation of ± 15 kc. and having a level of 0.5 v. and determine whether the lamp voltage exceeds lamp operate threshold voltage and whether the audio output exceeds one-half the manufacturer's rated output. Conduct this test at television channel frequencies 2 through 6 in the case of the television signal and over the ranges of 72.02–74.58 mc. and 75.42–75.93 mc. in the case of the FM signal.

NOTE: At each setting, determine whether the output is due to cross modulation or to direct demodulation of the undesired signal. Make this determination by turning off the desired carrier and noting audio output. If the output drops, cross modulation has been encountered, and the data should be recorded. If the output does not drop, the undesired signal is at a spurious response frequency, and the data should not be recorded.

T-14 SPURIOUS RESPONSE

Equipment Required:

AM signal generators to cover the band from 0.190 mc. to 1,500 mc.

Audio Output Meter (General Radio Model 583A or equivalent).

Voltmeter, if required, of suitable impedance and range for determining lamp operate threshold.

FM signal generator

Television signal amplifier capable of boosting the level of a TV signal to at least 3.5 v. peak. The frequency response characteristic of the amplifier shall be within 3 db over the range from -0.5 mc. to $+4$ mc. of the video carrier frequency. For the purpose of this test, a simulated TV signal may be used. Such simulated TV signal shall be an RF signal pulse modulated at a rate of 60 p.p.s. The pulse duration shall be 800 to 1,000 μ s, and the rise and decay time shall not exceed 0.08 μ s.

Measurement Procedure:

Determine whether the voltage across the indicator lamp(s) exceeds lamp operate threshold or the audio output exceeds one-half rated output when:

1. The RF input signal has a level of 0.5 v. is amplitude modulated 30% successively at 400, 1,300, and 3,000 c.p.s. and its radio-

frequency is varied over the range from 0.190 mc. to 15,000 mc. excluding the band 65 mc. to 85 mc.

2. The RF input signal is a television signal having a level of 3.5 v. and frequencies of television channels 2 through 6.

3. The RF input signal has a level of 0.5 v., is frequency modulated successively at 400, 1,300, and 3,000 c.p.s. and its center frequency is varied over the range of 65 mc. to 85 mc., excluding the band 74.6 mc. to 75.4 mc.

T-15 NOISE BANDWIDTH

Equipment Required:

Signal Generator (Hewlett Packard Model 608B or equivalent).

Voltmeter, if required, of suitable impedance and range for determining lamp operate threshold.

Measurement Procedure:

Apply to the receiver input an RF signal and determine the signal level required to produce lamp operate threshold over the RF signal frequency range from 75 mc. -10 kc. to 75 mc. $+10$ kc.

T-16 LAMP OPERATE SELECTIVITY

(Applies only to receivers designed to operate a separate lamp for each modulation frequency.)

Equipment Required:

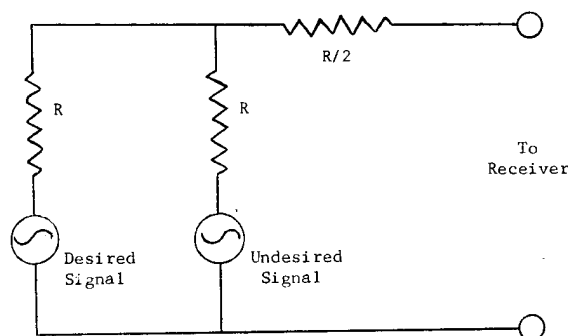
RF Signal Generator (Hewlett Packard Model 608B or equivalent).

AF Signal Generator (Hewlett Packard Model 200B or equivalent).

Voltmeter of suitable impedance and range for determining the voltage across the indicator lamps or the relay coils.

Measurement Procedure:

Apply to the receiver input an RF signal. Determine the voltage across the indicator lamps not intended to be lit over the RF input signal range from that producing lamp operate threshold to 200,000 μ v.



R=characteristic impedance of the transmission line for which the receiver is designed.

FIGURE 1—COMBINING UNIT